Study of Magnetic Field's effect on events in HI collisions.

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Motivation

- In HI Collision (HIC), an extremely strong ($\sim 10^{15}$Tesla) Magnetic Field (MF) is induced.
- Could we observe the effect of this MF on the events in HIC by looking for opposite deflection of + & - particles?

  (NOT a direct measurement of chiral magnetic effect but a test of an important ingredient)
- We are trying to answer this question based on:

  a) the data analysis

  Au+Au 200 GeV 2007 $\sim 50 \cdot 10^6$ events

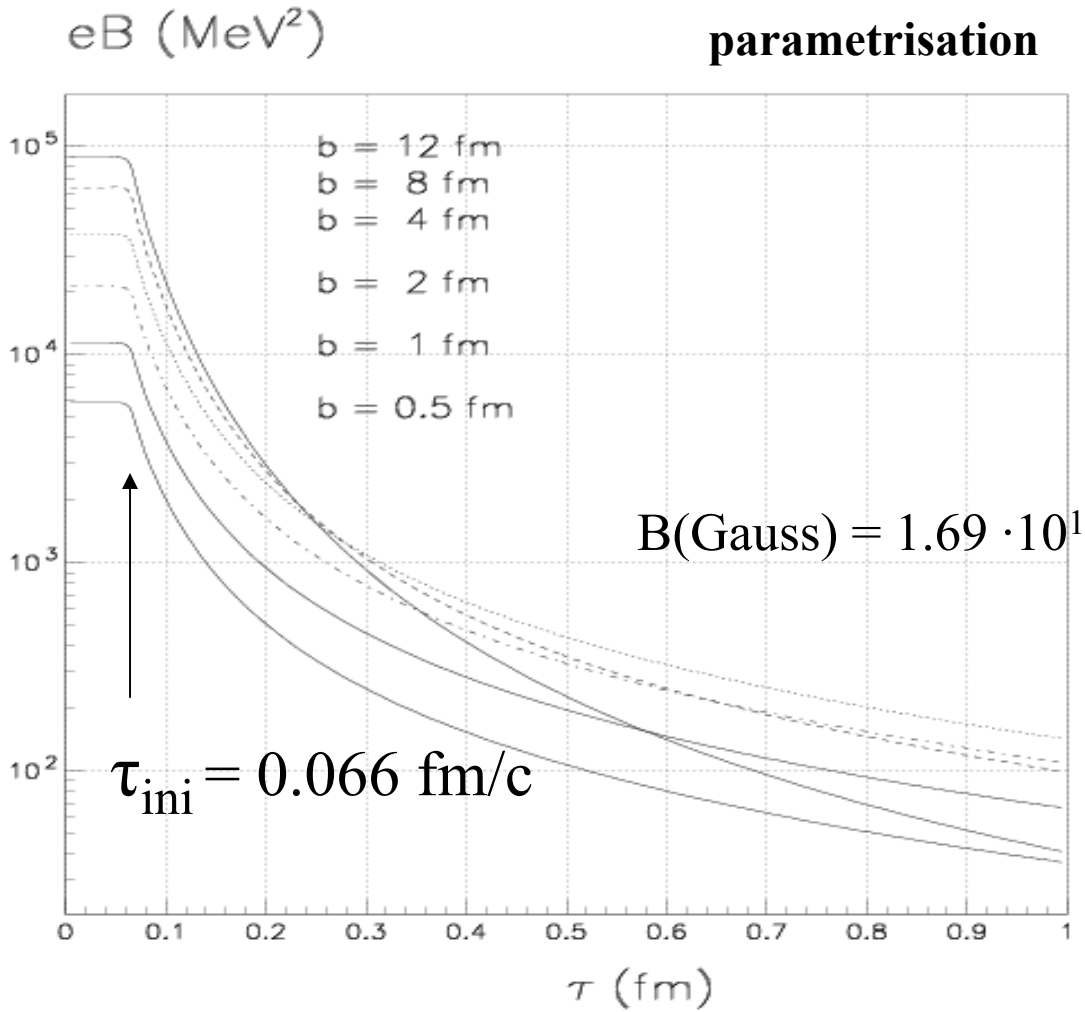
  b) simulation (with different assumptions)

  $10 \cdot 10^6$ or $50 \cdot 10^6$ events

Magnetic Field

D.Kharzeev et al./N.P. A803 (2008) 227-253

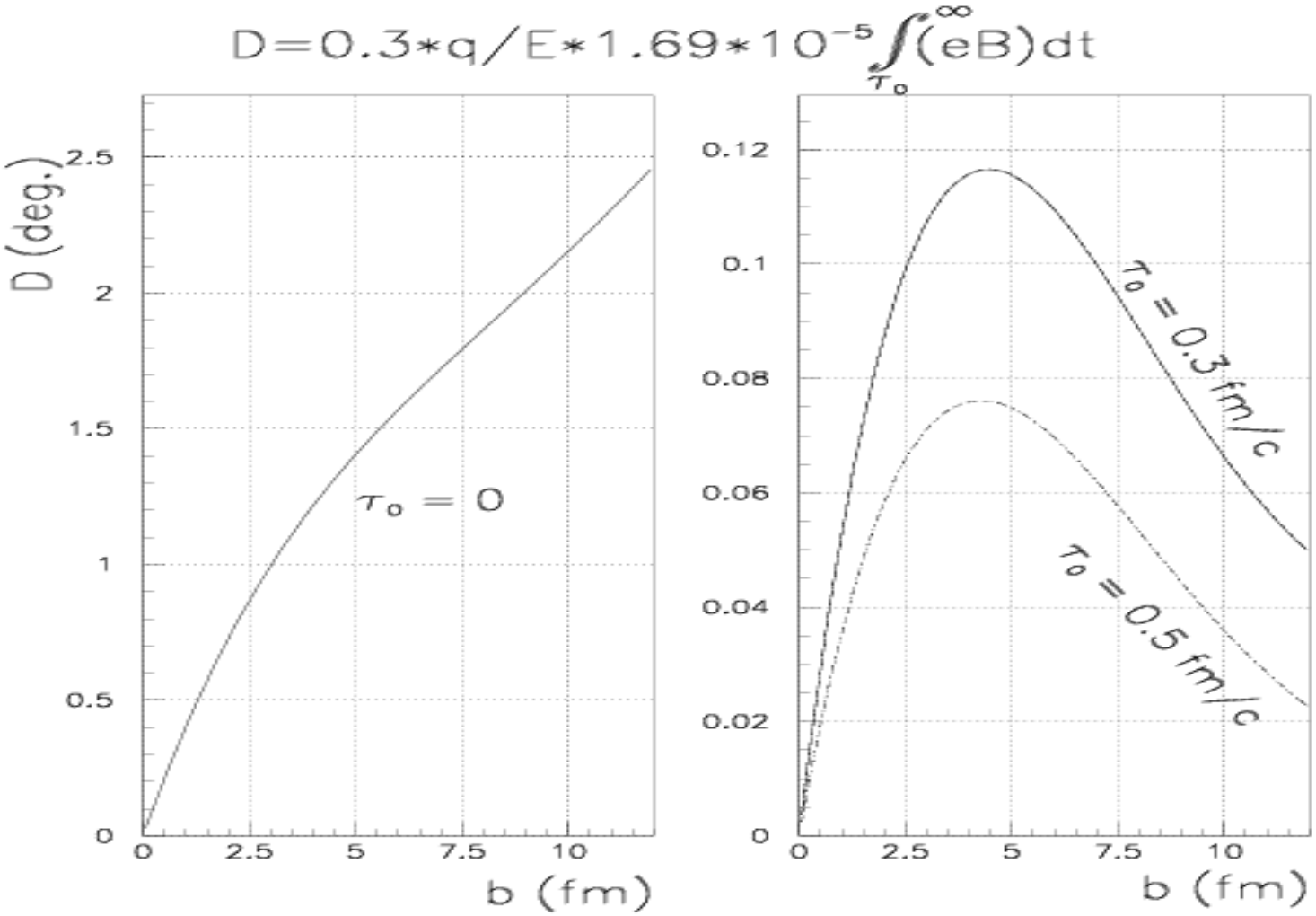
parametrisation



$B(\text{Gauss}) = 1.69 \cdot 10^{14}\ eB\ (\text{MeV}^2)$

$\tau_{ini} = 0.066$ fm/c

Deflection for E = 1 GeV and q=1



Simulation conditions and assumptions

- Idea is to do simple simulation to estimate rough magnitude of signal
- MF is assumed to be uniform in space
- Besides many others effects NOT included in our simulation model, we ignore the following potentially important factors:

  a) effect of electric field induced in HIC

  b) effect of magnetic moments interaction with MF

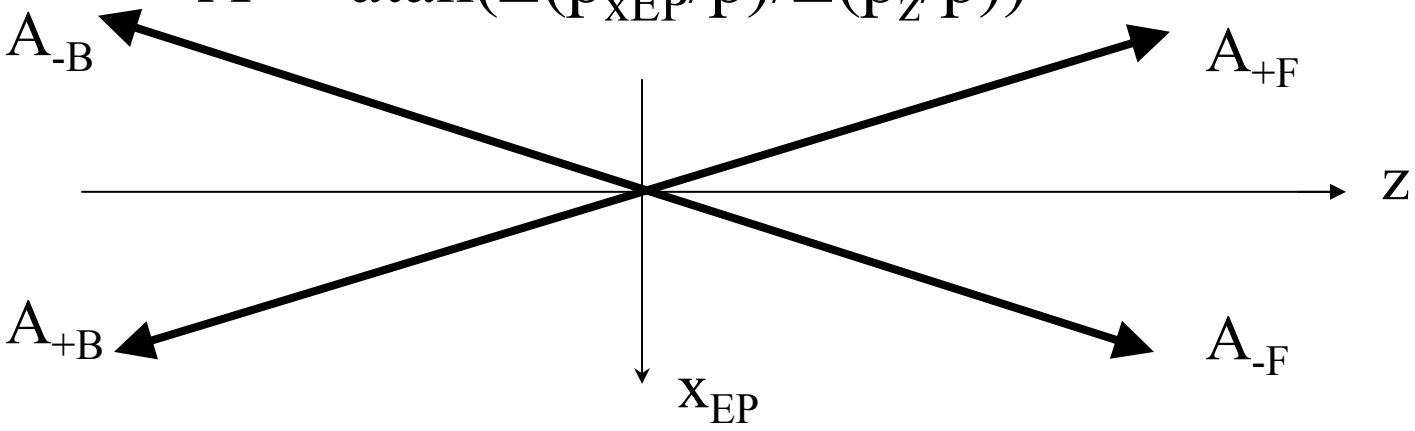
Simulation conditions and assumptions (continued)

- 200 GeV Au+Au events generated with proper multiplicity, dN_{tr}/dp_t and pseudorapidity distributions in final state

- Each track deflects according to the event's MF and track's Energy, smears around its initial direction (dilution due to fragmentation, etc.)

Observables (event by event).

$$A = \text{atan}(\Sigma(p_{xEP}/p)/\Sigma(p_z/p))$$

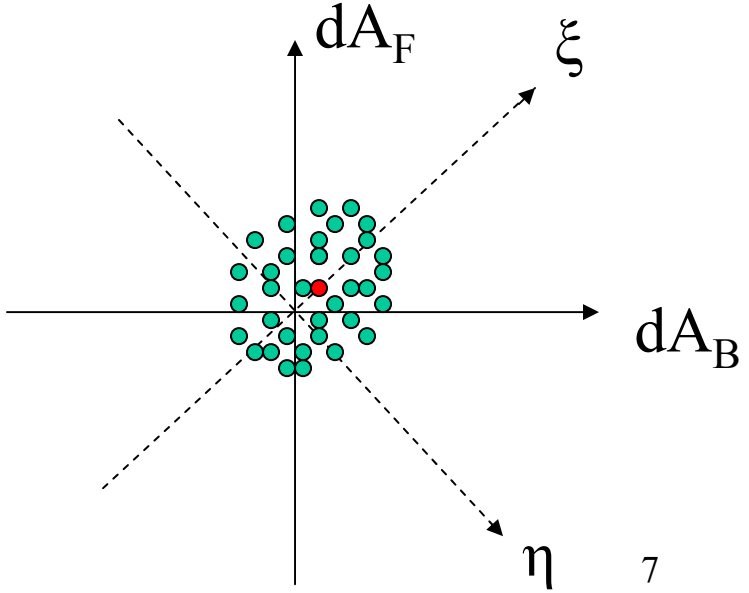


$$dA_B = A_{-B} - A_{+B}$$

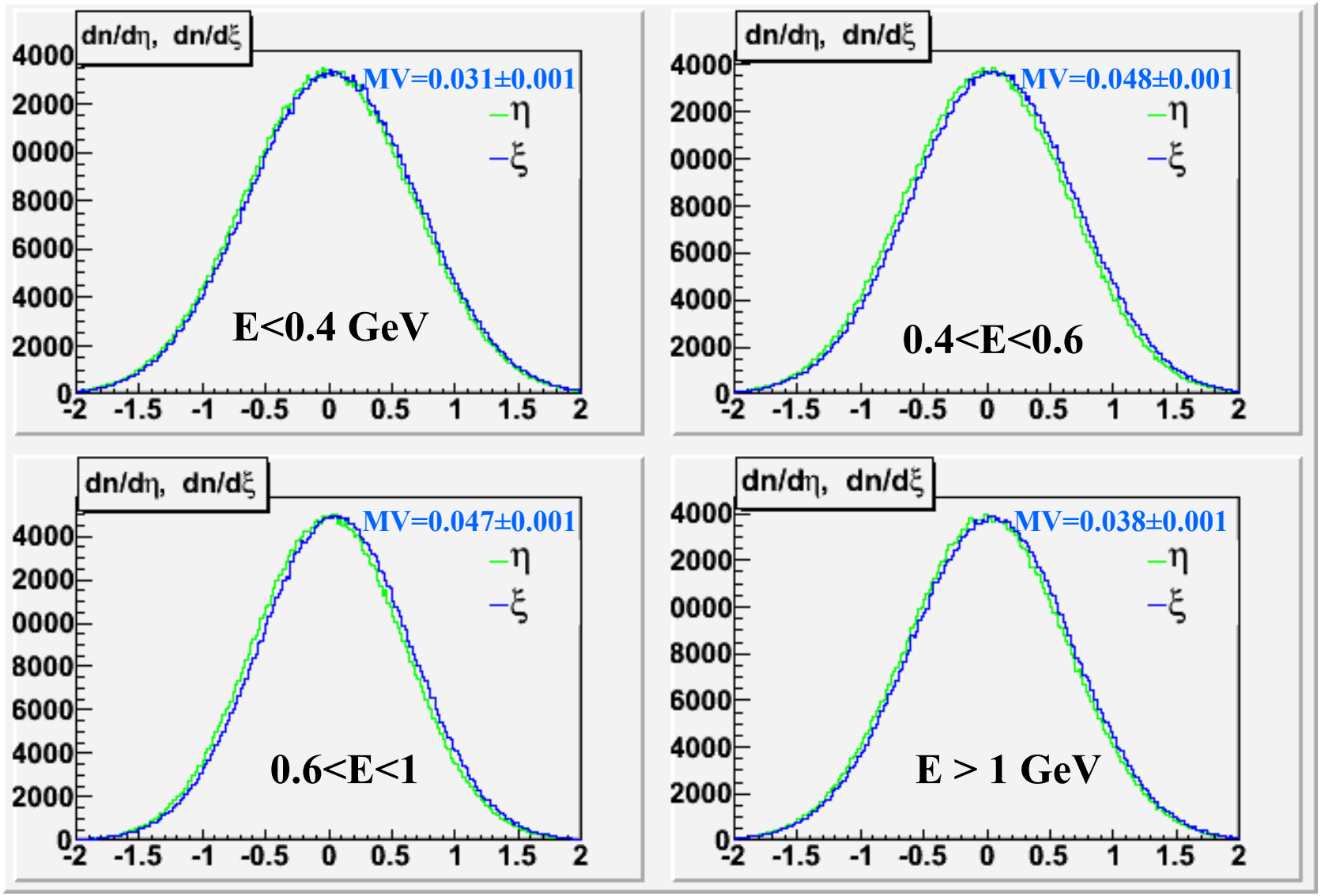
$$dA_F = A_{-F} - A_{+F}$$

$$\xi = (dA_B + dA_F)/\sqrt{2}$$

$$\eta = (dA_B - dA_F)/\sqrt{2}$$



$dn_{ev}/d\eta$, $dn_{ev}/d\xi$ (simulation)

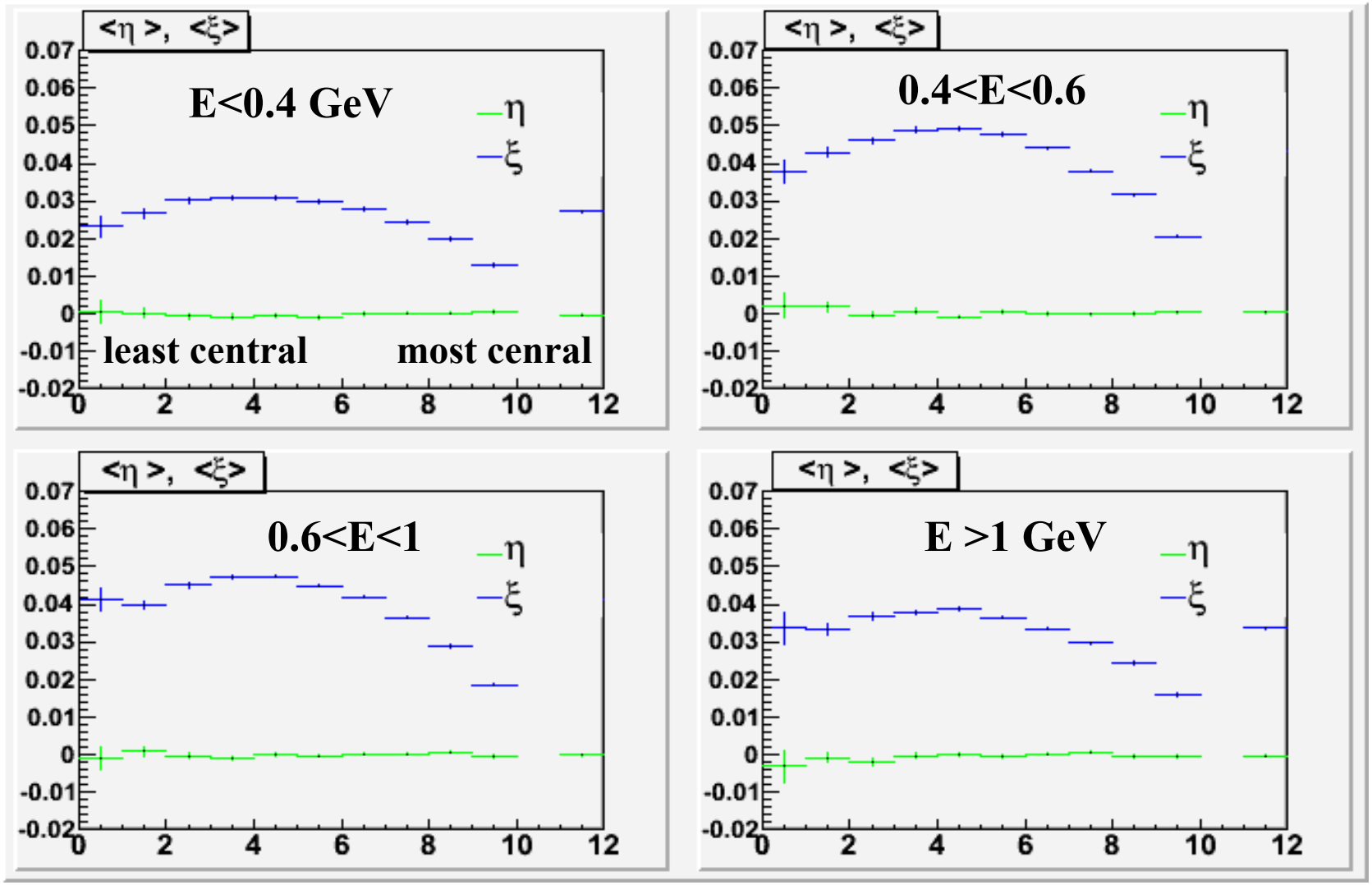


η, ξ

η, ξ

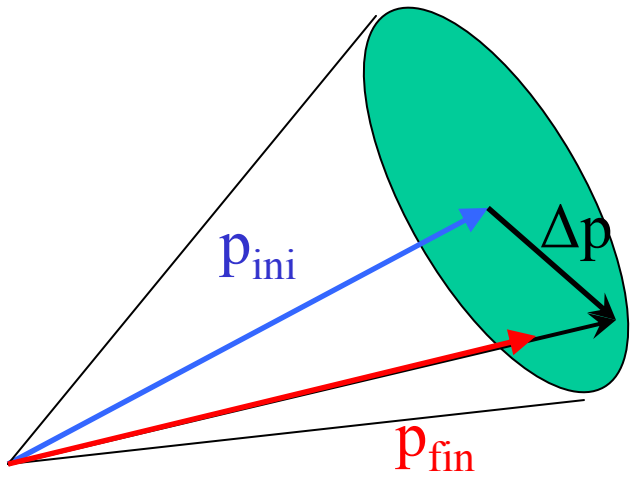
<η>, <ξ> with no dilution

(simulation, 10M ev.)



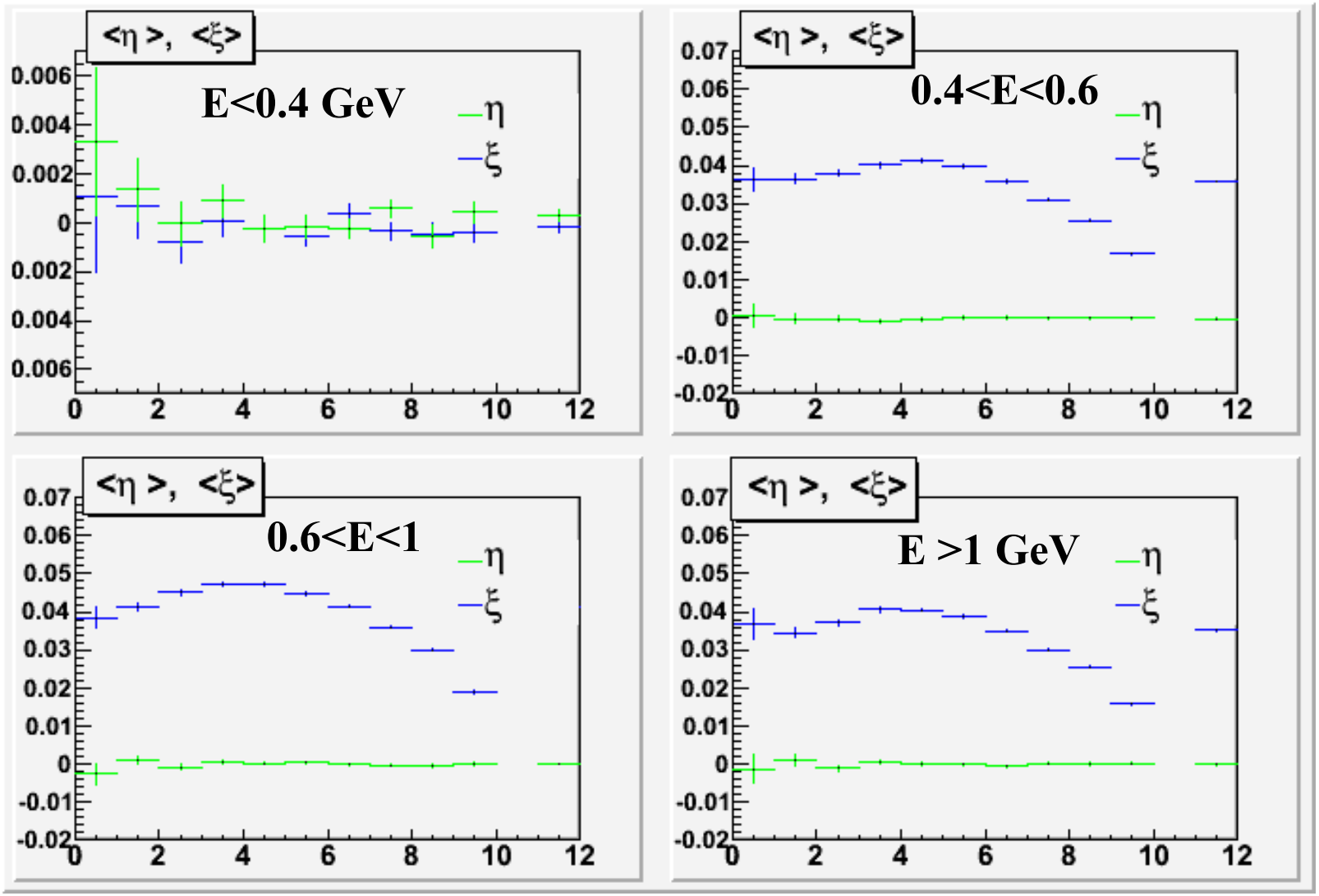
p – dilution (fragmentation)

$\sigma(\Delta p) = 100$ & 200 MeV/c

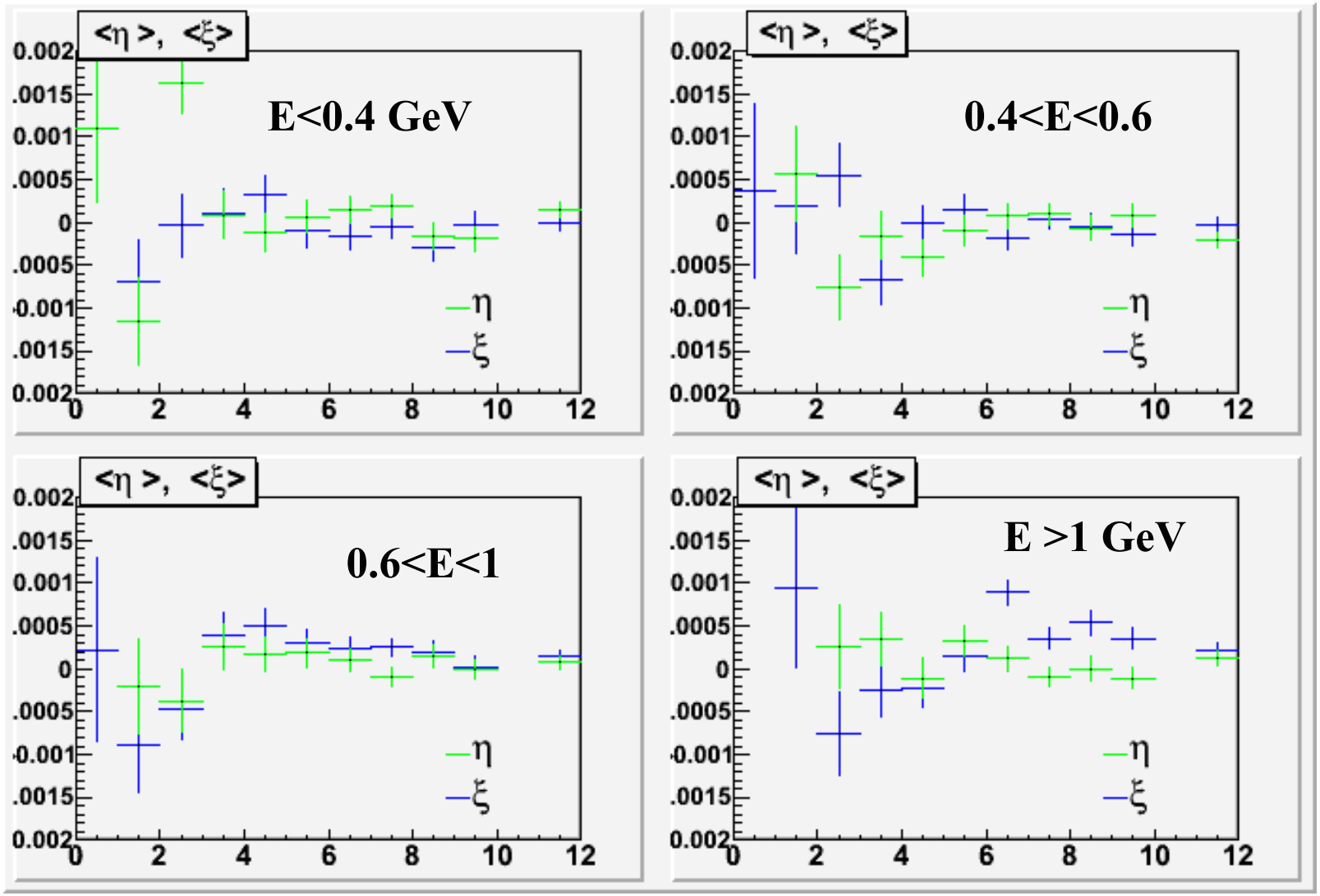


<η>, <ξ> with 200 MeV/c dilution

(simulation,10M ev.)

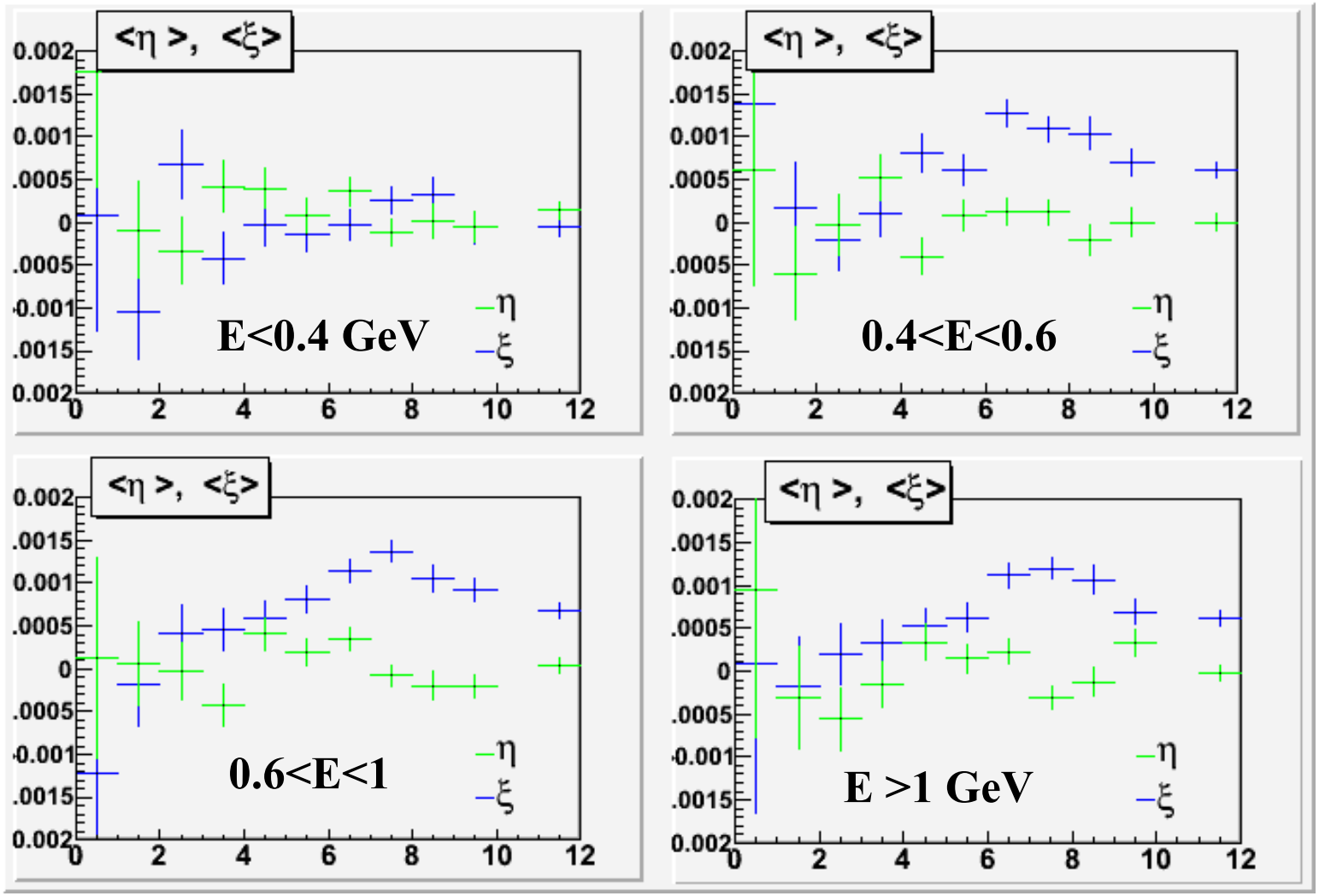


<η>, <ξ> data (STAR preliminary)



mC mC

<η>, < ξ > with 200 MeV/c dilution but deflection with τ_0=0.5 fm/c (simulation,50M ev.)



Conclusion

- MF deflection signal observed in the real data is of the order of 10^{-4} or lower
- Significant signal ($\sim 10^{-2}$) was observed in the simulation with MF starting at $\tau_0 = 0$.

  Dilution (fragmentation, etc.) affects the signal for low energy particles only.
- Simulation results for $\tau_0 = 0.5$ fm/c are much lower ($\sim 10^{-3}$) than for $\tau_0 = 0$ but still ~ 10 times bigger than the data points.

Future

- Theory:

  τ_0 = ?

  4-d magnetic field model and event generator

- Experiment:

  PID

  v_1 separately for + & -